

QUESTION

The frequency of the highest note on the piano is 4,186 Hz.

- a.) How many harmonics of that note can be heard?
- b.) How many harmonics of that note one octave below can be heard?

SOLUTION

a)

If the fundamental frequency is f , the harmonics have frequencies $2f, 3f, 4f, \dots$

etc. In humans the audible range of frequencies is usually 20 to 20,000 Hz

So, the fundamental frequency is $f_0 = 4186 \text{ Hz}$

The first harmonic frequency is 8372 Hz

The second harmonic frequency is 12558 Hz

The third harmonic frequency is 16744

The fourth harmonic frequency is 20930 Hz – out of the audible range.

Hence, three harmonics of that note can be heard.

Or, another way of solving this problem:

As $\frac{20000}{4186} = 4.77$, we can hear 3 harmonics (except fundamental), and the fourth

harmonic is out of range.

b)

The frequency of this note one octave below is $f = \frac{4186}{2} = 2093 \text{ Hz}$

As $\frac{20000}{2093} = 9.55$, we can hear 8 (except fundamental) harmonics with

frequencies (4186 Hz, 6279 Hz, 8372 Hz, 10465 Hz, 12558 Hz, 14651 Hz, 14651 Hz, 18837 Hz)

ANSWER

a) 3

b) 8